CLIMATE CONTRIBUTION

BUYER'S GUIDE

Carbon Removals: Understanding and Incorporating them into your Carbon Portfolio

February 2025

ClimateSeed

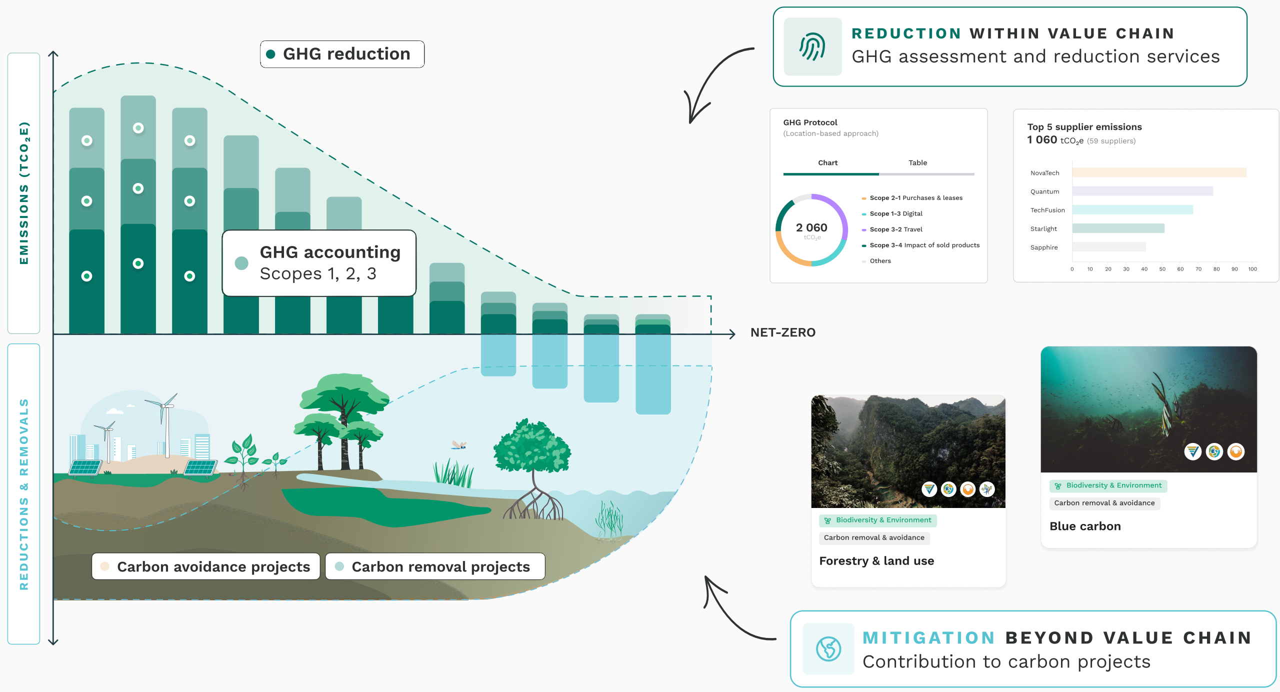
About ClimateSeed

Founded in 2018, ClimateSeed is an **impact-driven company** that supports over 200 organizations in their decarbonization journey.

ClimateSeed provides **consulting services** and **technological tools** to measure organizations' greenhouse gas emissions (GHG assessment), define reduction strategies aligned with science-based targets (SBTi), and contribute to premium carbon sequestration and avoidance projects, in line with the UN Sustainable Development Goals.

SOFTWARE SUITE + CONSULTING

Financed by AXA Impact Fund Investment Managers



Member of

Certified

Table of contents

Carbon Removal vs Avoidance

Carbon reduction projects can be grouped into two main categories: carbon removal and carbon avoidance projects.

Carbon avoidance is the prevention of future carbon emissions being released into the atmosphere. Projects can include managing and conserving forests (natural carbon sinks), switching to renewable energies and implementing more efficient household devices.

Carbon removal is the elimination of existing carbon emissions, by absorption, after they have entered the atmosphere. Activities that remove carbon can take multiple forms, including nature-based removals, such as reforestation, afforestation & revegetation as well as tech-based solutions. Each type of carbon reduction is as important and has its own place in the spectrum of climate solutions.

At ClimateSeed, we do not encourage one over the other and consider both equally significant and complementary to each other. Carbon avoidance and removal credits help companies to mitigate emissions outside their value chain, whereas unabatable residual emissions must be neutralized with permanent carbon removals [1].

Carbon Removal

Carbon Avoidance

Avoidance projects focus on avoiding future carbon from being released into the atmosphere

Removal projects focus on removing existing carbon already present in the atmosphere

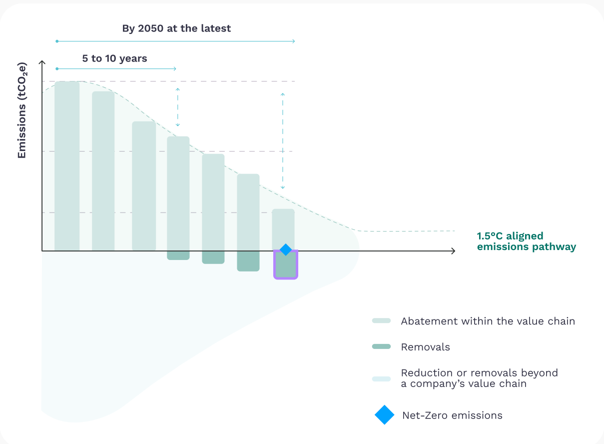
The Importance of Carbon Removal

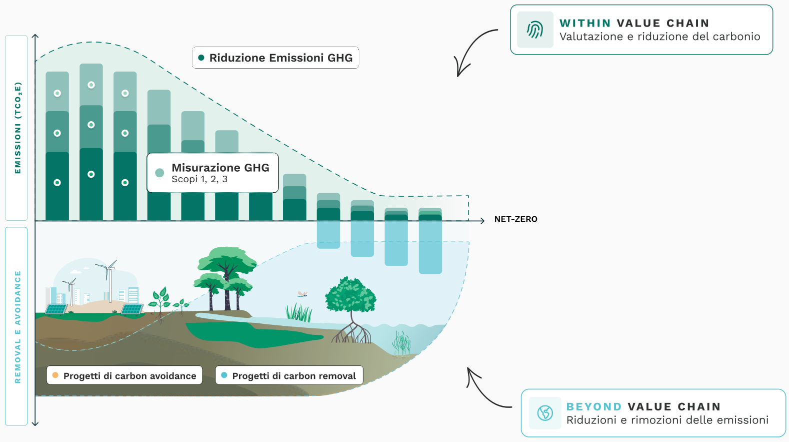
As the world strives to limit global warming to 1.5°C, carbon removal has emerged as an essential component of climate strategies. While reducing emissions remains the top priority, achieving net-zero targets, as outlined in frameworks like the Science Based Targets initiative (SBTi), often requires removing carbon dioxide (CO_2) from the atmosphere.

Carbon removal methods, ranging from Nature-based Solutions like reforestation, to technological approaches, such as direct air capture, play a dual role: accounting for residual emissions and helping to reverse past accumulations of CO_2. The scale of their contribution varies across different climate goals, underscoring the need for robust and scalable solutions to complement mitigation efforts.

Organizations are encouraged to go further than their science-based abatement targets to mitigate emissions beyond their value chains by:

1. Setting near-term (5-10 years) and long-term (target year 2050 or before) reduction targets.
2. Reducing emissions beyond their value chain (both avoidance and removal projects).
3. Once residual emissions reach 90% reduction, neutralize remaining residual emissions through carbon removal [2].





The graphs above illustrate a pathway to achieving net-zero emissions by 2050, emphasizing the importance of emissions abatement within the value chain and removals through carbon credits. The left graph outlines a gradual emissions reduction strategy aligned with the 1.5°C target, while the right graph distinguishes between reductions within the value chain and additional efforts beyond it, such as carbon removal and avoidance projects.

Comparing Standards

Below, you will find a comprehensive overview of various standards, along with detailed insights into Nature-based Solutions, Hybrid Solutions, and Engineered Solutions. Some methodologies will generate both avoidance and removal credits, ie. Improved Forest Management.

	NATURE-BASED SOLUTIONS (NBS)				HYBRID SOLUTIONS		ENGINEERED SOLUTIONS (ES)	
	Afforestation/ Reforestation	Agriculture	Mangroves	Seagrass	Biochar	Enhanced Rock Weathering	Direct Air Capture and Storage	Bioenergy with Carbon Capture and Storage
Verified Carbon Standard	●	●	●	●	●			
Gold Standard for the Global Goals	●	●	●					
Climate Action Reserve	●	●	●		●			
Label Bas Carbone	●	●	●	●				
ACR	●				●		●	
Plan Vivo	●	●	●					
puro.earth					●	●	●	●
Isometric					●	●	●	●
riverse					●			●

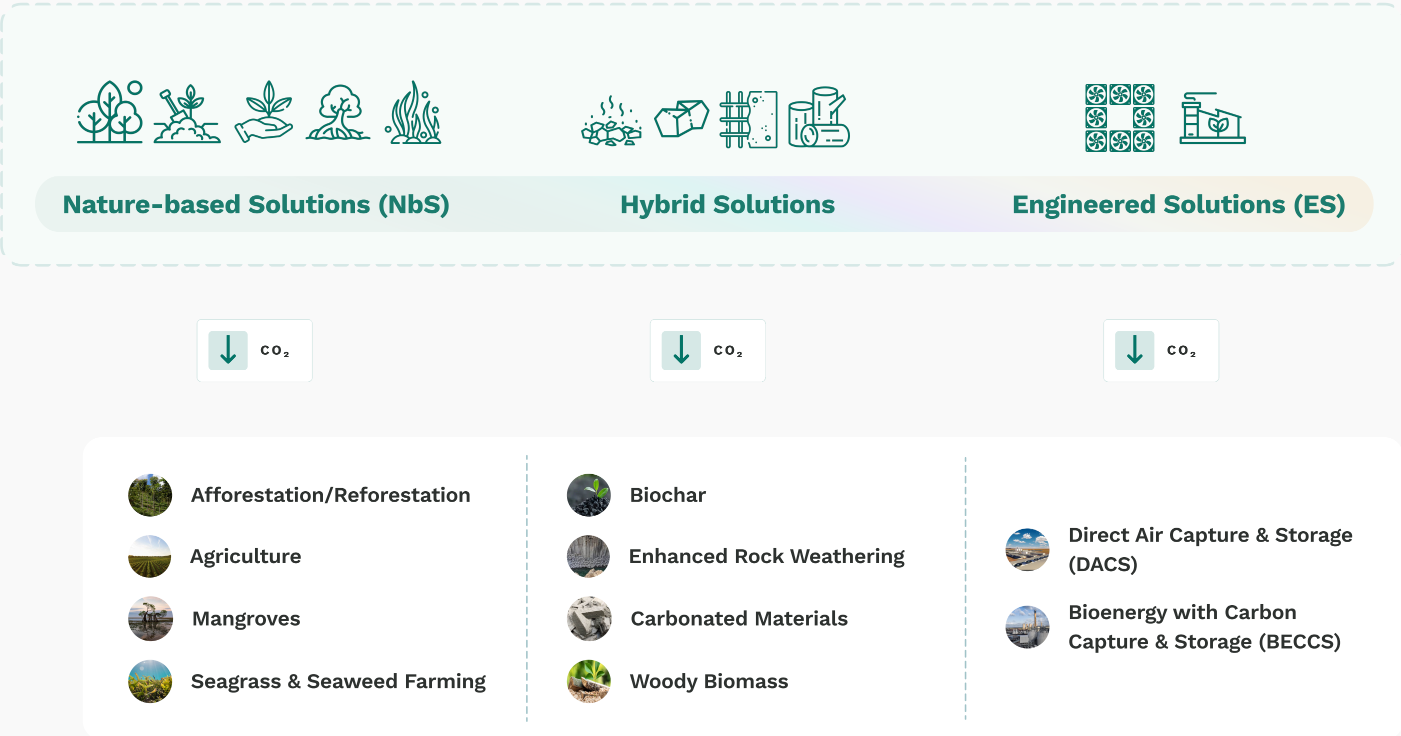
Note: Some methodologies might still be under development.

The Carbon Removal Methods

As the global efforts to combat climate change intensify, CDR methods and projects are diversifying, spanning from harnessing the power of natural ecosystems to employing cutting-edge carbon engineering solutions that are in line with the Intergovernmental Panel on Climate Change (IPCC). Understanding different CDR methods and how they span across the Voluntary Carbon Market (VCM) is pivotal to shaping effective climate action plans in the race to reach net-zero emissions.

This guide delves into the three major CDR methods: Nature-based Solutions, Hybrid Solutions, and Engineered Solutions, providing a comprehensive overview of the key characteristics of each and how they compare in the market. Together, they weave a complex tapestry of solutions that could play pivotal roles in achieving climate targets and fostering a sustainable future. At ClimateSeed, we maximize positive environmental and social impacts by providing climate solutions to support meaningful carbon removal projects, leveraging the pivotal and necessary financing mechanisms of the VCM.

CDR is increasingly recognized as essential for achieving Net-Zero emissions by accounting for residual emissions from hard-to-decarbonize sectors like aviation and agriculture [3]. It also plays a crucial role in removing excess CO_2 from the atmosphere, with the IPCC emphasizing its necessity in meeting Net-Zero goals [4].



Nature-based Solutions (NbS)

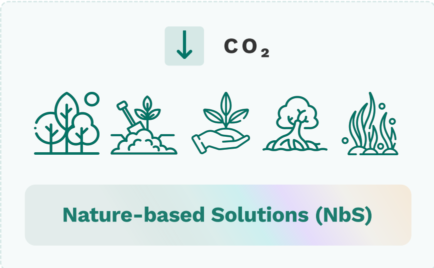
NbS leverage the natural capacity of ecosystems — such as forests, wetlands, grasslands, and other natural habitats— to absorb and retain CO_2 from the atmosphere over time, contributing to both carbon dioxide removal and ecosystem restoration.

These solutions include projects like reforestation, afforestation, wetland restoration, and sustainable land management practices. NbS projects promote biodiversity, are community-oriented and aim to enhance both carbon sequestration and increase ecological benefits.

Characteristics

- Low capital investment
- Large volumes
- High co-benefits
- €15–€100 price range
- Ex-post and ex-ante credits
- Higher risk of reversal

- **Afforestation/Reforestation**
- **Agriculture**
- **Mangroves**
- **Seagrass & Seaweed Farming**



Afforestation, Reforestation & Revegetation (ARR)

Afforestation is the process of planting trees on land that has never been forested, while reforestation involves replanting trees in areas that have undergone deforestation. Meanwhile, revegetation focuses on restoring vegetation cover in regions where it has been lost.

ARR projects often include selecting appropriate native species to restore ecological balance and improve biodiversity. The projects may involve community engagement and provide social benefits by creating jobs and enhancing local livelihoods. Additionally, ARR projects can improve water cycles and prevent soil erosion. These efforts contribute significantly to mitigating climate change while also addressing environmental and social issues.

Characteristics

- Restored forests provide habitats for wildlife, promoting biodiversity.
- Prevents of erosion and and enhances soil fertility.
- Establishing no-fishing zones
- Improves water cycle quality, and retention.
- Creation of local jobs and community engagement.

Permanence: Decades to one century

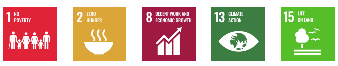
Price range: €15–€40

Agroforestry in Punjab

The project implements sustainable agroforestry practices among small-scale farmers across different districts of Punjab. The region has suffered from land degradation as a result of the traditional rice-wheat cropping system that has historically contributed towards food security of the country. The project goals include increased tree cover, local biodiversity conservation and enhanced soil health.

Talk to a carbon expert

Supporting UN Sustainable Development Goals



Agriculture

Agricultural carbon projects aim to reduce greenhouse gas emissions and sequester carbon in agricultural landscapes through improved land management practices. Techniques such as no-till farming, cover cropping, crop rotation, and agroforestry are employed to enhance soil organic carbon levels. These practices not only sequester carbon, but also improve soil health, leading to increased agricultural productivity and resilience to climate change.

Projects often involve training and supporting farmers to adopt sustainable practices. By improving soil structure and fertility, these projects also reduce the need for chemical fertilizers, further lowering emissions. Overall, they promote sustainable agriculture and enhance food security. These projects generate both removal and avoidance credits.

Characteristics

- Increases soil carbon storage, reducing atmospheric CO_2 levels.
- Improves water retention and reduces runoff.
- Enhances soil structure and fertility, boosting crop yields.
- Reduces input costs and increases resilience for farmers.

Permanence: Years to decades

Price range: €30–€100

Talk to a carbon expert

Regenerative Agriculture in Europe

The project aims to turn the agriculture sector, which is responsible for about 20% of global GHG emissions, into a solution to combat climate change. By working with more than 1,000 farmers across France, Belgium and the UK, the project supports farmers to implement regenerative farming practices, resulting in reduced GHG emissions and restoring farmlands.

Supporting UN Sustainable Development Goals

Mangrove

Mangrove restoration projects focus on replanting and conserving mangrove forests along coastlines. Mangroves are unique ecosystems that sequester significant amounts of carbon both in their biomass and in the soil they stabilize. These projects typically involve community participation and can enhance local fisheries by providing nursery habitats for marine species.

Mangroves also act as natural barriers against storm surges and coastal erosion, protecting human settlements and infrastructure. Additionally, they improve water quality by filtering pollutants and trapping sediments. The combination of these benefits makes mangrove restoration a highly effective Nature-based Solution for climate mitigation and adaptation.

Characteristics

- Mangroves store large amounts of carbon in biomass and soil.
- Reduce erosion and protect against storm surges.
- Provide habitats for numerous marine and terrestrial species.
- Enhance local fisheries by providing breeding grounds.
- Protect coastal communities and support livelihoods.

Permanence: Decades to one century

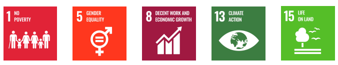
Price range: €25–€40

Mangrove Restoration in Mexico

The blue carbon project in the Gulf of Mexico conserves 700 hectares of mangroves, including white, red, and black mangrove species, while restoring biodiversity and protecting species. As Mexico's first certified mangrove project, it is community-led, promotes equitable employment, shares revenues locally, and fosters sustainable practices, reducing degradation and benefiting the local economy.

Talk to a carbon expert

Supporting UN Sustainable Development Goals



Seagrass & Marshes

Seagrass restoration projects focus on planting and conserving seagrass meadows in shallow coastal waters. Seagrasses are highly effective at sequestering carbon due to their fast growth rates and the large amounts of organic carbon stored in the sediments they trap. These projects often involve scientific monitoring and community engagement to ensure successful restoration.

Seagrass meadows provide critical habitats for a variety of marine species, including fish, shellfish, and sea turtles. They also play a vital role in maintaining water quality by stabilizing sediments and filtering nutrients. Overall, seagrass restoration contributes to carbon sequestration, biodiversity conservation, and the health of marine ecosystems.

Characteristics

- Prevent erosion and maintain coastal integrity.
- Support diverse marine life and ecosystems.
- Enhance local fisheries through habitat provision.
- Strengthen resilience of coastal areas to climate impacts.

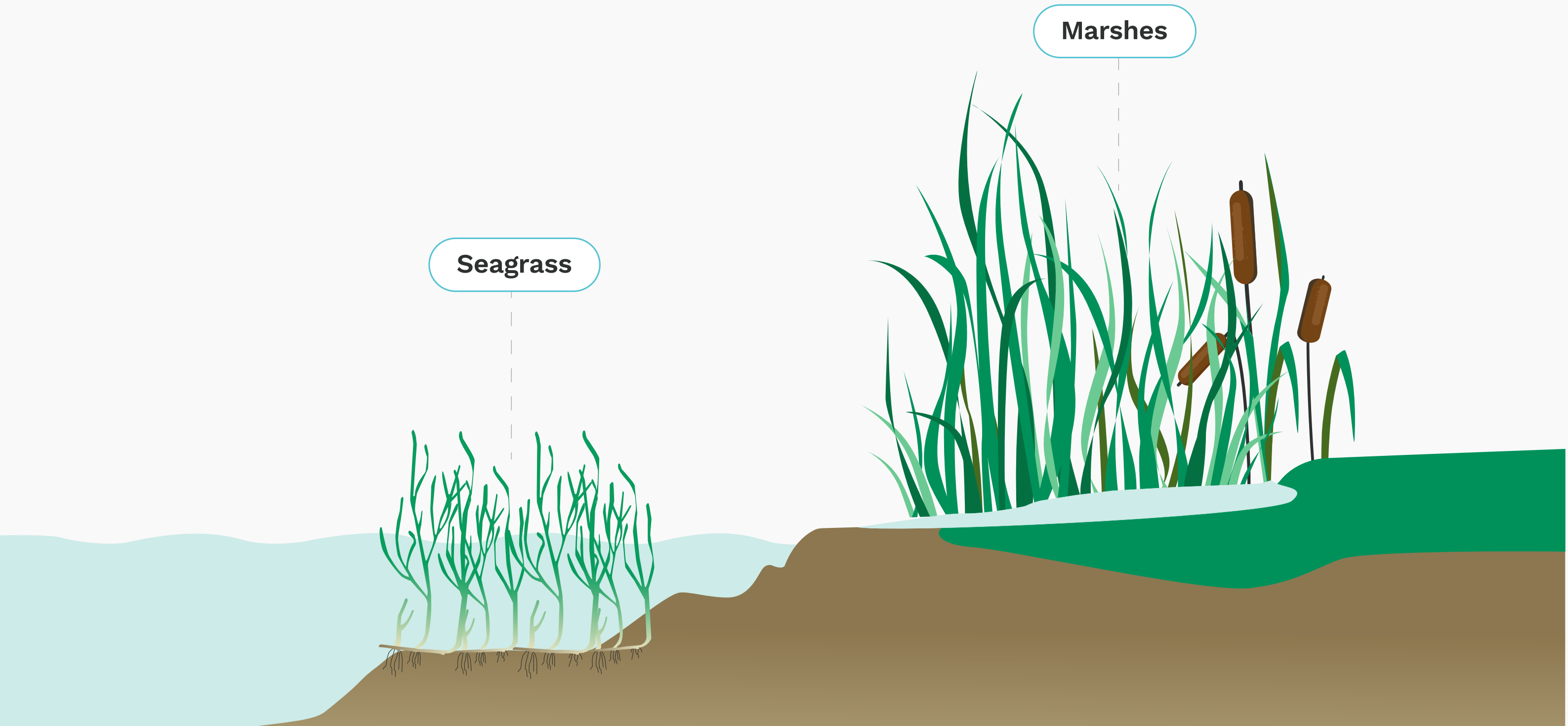
Permanence: TBD
Price range: TBD

Wetland Project in Venice

In the Northern Lagoon of Venice, traditional fish farming and improved brackish water flow maintain biodiversity, prevent anoxia, and enhance CO_2 absorption through algae growth, preserving the lagoon's ecosystem and heritage.

Talk to a carbon expert

Supporting UN Sustainable Development Goals



Hybrid Solutions

Hybrid solutions represent an innovative approach of integrating both Nature-based and Engineered Solutions to maximize CO_2 removal from the atmosphere. These projects recognize the complementary nature of ecological and technological interventions. The objective of hybrid removal projects is to maximize carbon removal efficiency and environmental benefits through a synergistic approach.

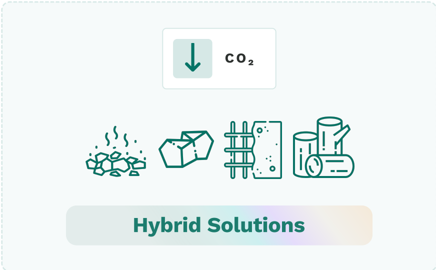
Characteristics

- Medium to high capital investment
- Small volumes
- Medium co-benefits
- €100–€600 price range
- Mostly ex-ante credits
- Low risk of reversal

The primary goal of Carbon Capture & Utilization (CCU) is not only to **remove CO_2** from the atmosphere, but also to find **novel and practical** uses of carbon as raw material.

CCU can take several forms, including the **production of chemicals, biofuels, plastics, or construction materials** from CO_2 emissions.

- **Biochar**
- **Enhanced Rock Weathering**
- **Carbonated Materials**
- **Woody Biomass**



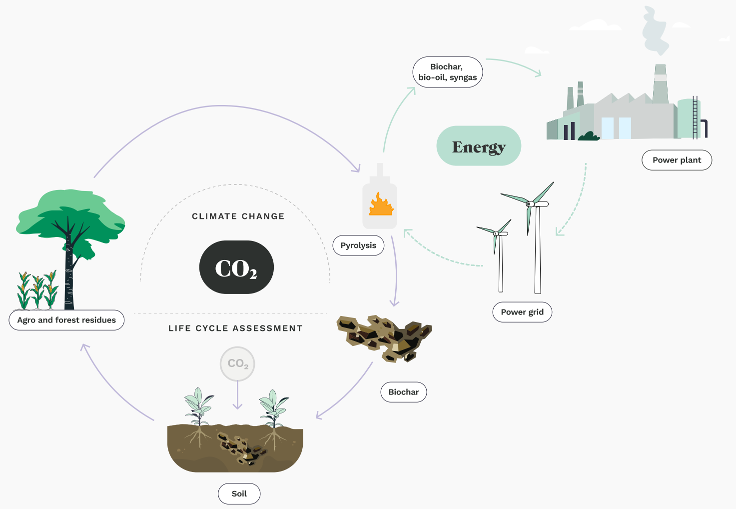
Biochar

Biochar is obtained from heating biomass (wood, leaves, straw, or other biosolids) at high temperatures without oxygen. This process, known as pyrolysis, concentrates carbon in a form that is very resistant to biological decomposition.

Biochar can be used for agricultural and industrial purposes, such as to enhance the quality of soils or remove pollutants from wastewater. Biochar is a powerful tool for removing carbon dioxide from the atmosphere and has many social and environmental benefits.

How does it work?

Biochar is a fine-grained, carbon-rich material created through pyrolysis. This process entails heating biomass to high temperatures (350–700°C) in the absence of oxygen using specially designed furnaces [5].



Life cycle assessment of biomass [7].

Characteristics

- Improves agricultural productivity, by helping soils retain water and nutrients, and restoring degraded soils.
- Can be used for remediation of contaminated sites or as a sorbent for water treatment.
- Generates energy from the pyrolysis process.
- Avoids air pollution caused by biomass burning and diverts organic waste from landfill.

Permanence: +100 years

Price range: €70–€170+

Did you know?

In the VCS methodology VM0044, there are two types of pyrolysis recognized, “high technology” and “low technology”.

High technology pyrolysis has better control over the heat, gas capture, and temperature monitoring, resulting in a greater efficiency for reducing greenhouse gas emissions. Low technology pyrolysis can still produce stable carbon at comparable levels, but often lacks continuous measurement and heat recovery [6].

Enhanced Rock Weathering (ERW)

Rock weathering is a natural process that removes carbon from the atmosphere and usually takes thousands of years. ERW fast-tracks the carbon removal process by spreading crushed silicate rocks on surfaces, such as agricultural lands.

The CO_2 is removed, locking it for thousands of years, when the carbon in soil moisture and rainwater reacts with the surface area of the silicate rocks.

Characteristics

- Increase crop yield and enhance agricultural productivity.
- Amend degraded soils and reduces the need for fertilizers.
- Build plant resistance against pests and diseases Improve crop water retention, potentially increasing crop resilience to drought.

Permanence: +1,000 years

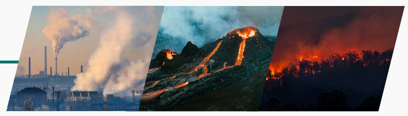
Price range: €200–€500

How does it work?

ERW is the chemical reaction between 3 main ingredients: rocks, water and CO_2. Through this chemical reaction, finely crushed rocks dissolve into the water, binding CO_2 in the process and storing it.

The water needed comes from naturally occurring rainfall or through the irrigation systems typically used in agricultural fields. Due to the large concentration of CO_2 in soils combined with the ample surface area, it makes sense to combine ERW projects with agriculture. For the CO_2 weathering reaction, rocks must contain easily weatherable minerals, such as olivine, which reacts fast with water and CO_2, one the most effective minerals. Basalt is a type of volcanic rock that is abundantly present and high in olivine thus making it a good first choice for ERW.

The water needed comes from naturally occurring rainfall or through the irrigation systems typically used in agricultural fields. Due to the large concentration of CO_2 in soils combined with the ample surface area, it makes sense to combine ERW projects with agriculture.



CO_2 is emitted into the atmosphere through natural processes (i.e., venting volcanoes, natural wildfires, decomposing biomass, etc.) or through anthropogenic activities (i.e., fossil fuel extraction and burning, mining, industrial processes, etc.)

For the CO_2 weathering reaction, rocks must contain easily weatherable minerals, such as olivine, which reacts fast with water and CO_2, one the most effective minerals. Basalt is a type of volcanic rock that is abundantly present and high in olivine thus making it a good first choice for ERW.

Engineered Solutions (ES)

Engineered Solutions involve the use of human-made technologies and innovative processes to capture and store GHG emissions from the atmosphere. These solutions are more focused on mitigating emissions directly, rather than relying on natural ecosystems.

Examples of ES include, Carbon Capture and Storage (CCS) technologies, Direct Air Capture (DAC) systems, and technologies that reduce emissions from industrial processes or energy production.

CCS technologies capture CO_2 emissions from industrial processes, power plants, or other sources and **stores** them **underground in geological formations** to **prevent their release** into the atmosphere.

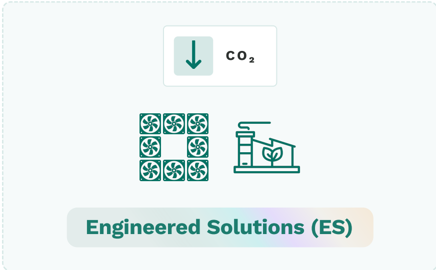
CCS aims to **permanently store** captured CO_2 and help create **net negative** greenhouse gas emissions.

Characteristics

- Very high capital investment
- Small volumes
- Low co-benefits
- €160–€1,000 price range
- Mostly ex-ante credits
- Low risk of reversal

Direct Air Capture and Storage (DACS)

Bio energy with Carbon Capture & Storage (BECCS)



Bioenergy with Carbon Capture & Storage (BECCS)

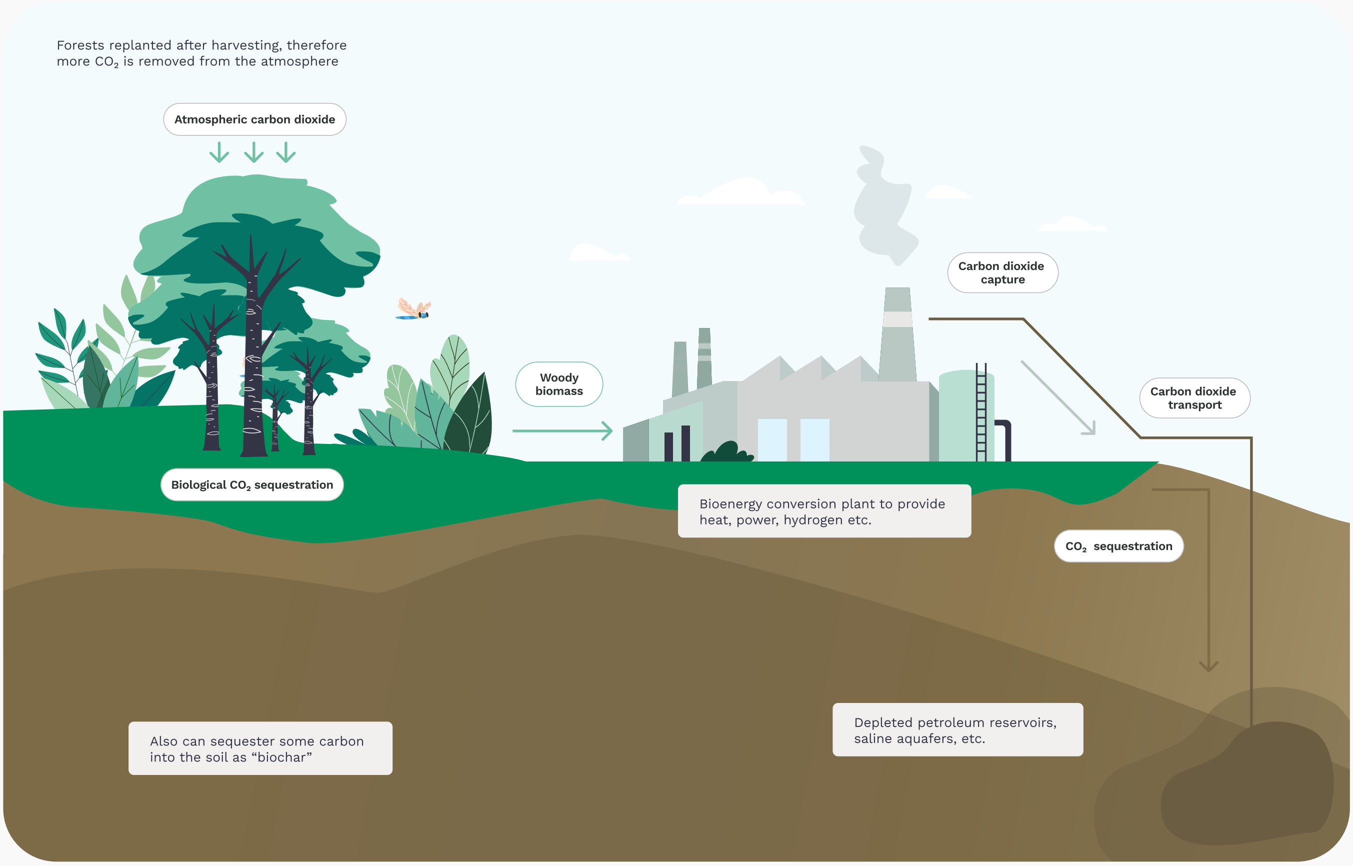
BECCS involves capturing and permanently storing CO_2 produced during the conversion of biomass into fuels or its direct combustion for energy generation.

BECCS is unique among carbon dioxide removal methods as it also generates energy. With the ability to produce high-temperature heat and fuels compatible with existing engines, BECCS can play a crucial role in decarbonizing sectors like heavy industry and aviation in the Net-Zero Emissions by 2050 Scenario [8].

Characteristics

- Possibility to implement in various sectors, ie. power generation, which is difficult to decarbonize.
- Integrate into existing bioenergy and power generation infrastructure.
- Contribute to energy security by diversifying energy sources and providing a stable form of bioenergy that isn't dependent on weather conditions, ie. solar [9].

Permanence: +1,000 years
Price range: €160-€1,000



Overview of the process [10].

Direct Air Capture & Storage (DACS)

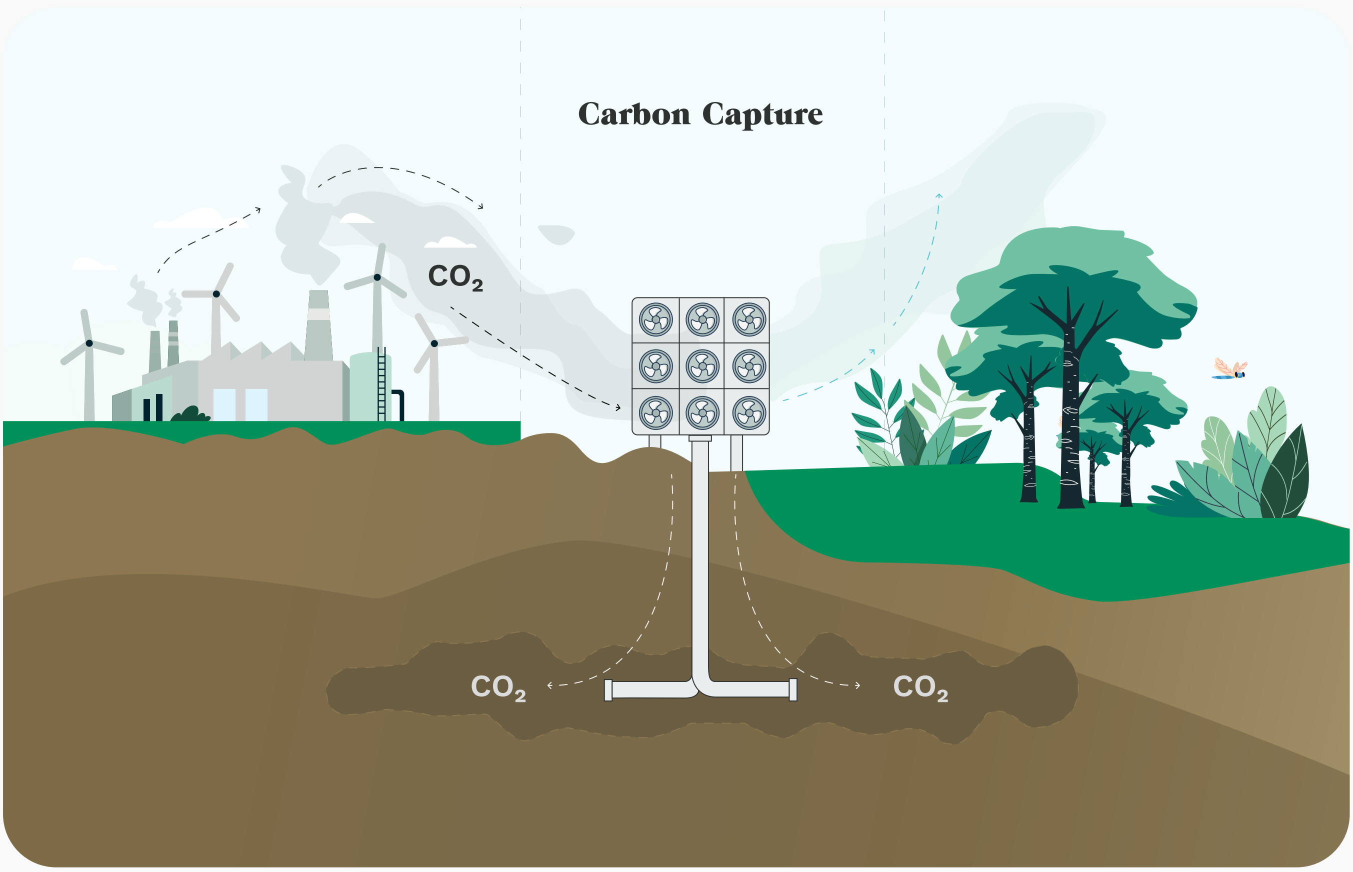
Geologically stored carbon involves the carbon sequestration and geo-storage, where CO_2 is captured from the atmosphere and stored permanently into deep geological rock formations where the CO_2 cannot escape back into the atmosphere.

DACS focuses on directly capturing CO_2 from the ambient air and storing it underground. It uses engineered technologies to remove carbon from the atmosphere, usually through chemical or physical processes.

Permanence: +1,000 years
Price range: €600-€1,000

Characteristics

- Contribute to air quality, as it removes not only CO_2, but also other pollutants and particulate matter from the air.
- Projects can create employment opportunities in R&D and the deployment of carbon capture technologies, fostering innovation and providing jobs and financial benefits.
- Can recycle CO_2 into valuable products like synthetic fuels or construction materials, reducing the need for fossil fuel extraction and the associated environmental impacts.



How do they compare?

The table compares Nature-based, Hybrid, and Engineered Solutions across key factors, such as; cost, co-benefits, volume, and risk. Nature-based Solutions have low capital and operational costs, provide high co-benefits, and offer large-scale potential, but come with a high risk of reversal. In contrast, engineered solutions require high investment and maintenance costs, offer lower co-benefits, operate at a smaller scale, but have a lower risk of reversal. Hybrid Solutions balance the characteristics of both approaches. Price ranges vary significantly, with Nature-based Solutions being the most affordable (€15–€50) and Engineered Solutions the most expensive (€160–€1,000), while all three solutions can be procured both ex-post and ex-ante.

In conclusion, carbon removal methods encompass a diverse range of approaches, each with its own unique characteristics. ClimateSeed has a variety of projects within each solution. See a full overview of the categories below.

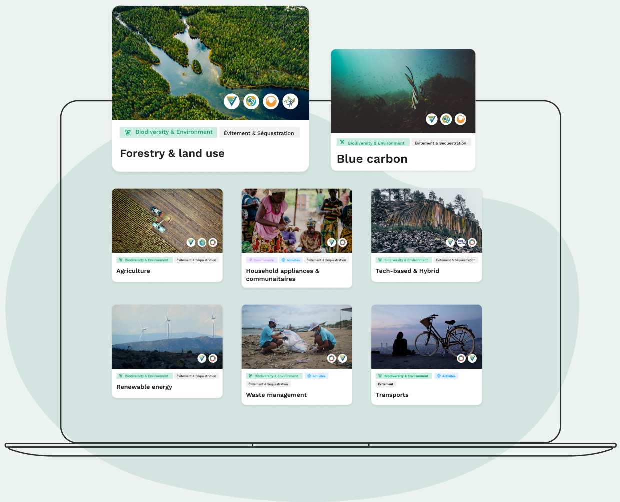
Factor	Nature-based Solutions	Hybrid Solutions	Engineered Solutions
Capital investment	Low		High
Operational & maintenance costs	Low		High
Co-benefits	High		Low
Volume	Large		Small
Risk of reversal	High		Low
Price range	€15–€100	€100–€600	€160–€1,600
Procurement type	*Ex-post & ex-ante*	*Ex-post & ex-ante*	*Ex-post & ex-ante*

Our approach to evaluating projects

Whether you are committed to reaching net zero, dedicated to preserving biodiversity, or looking to balance emissions, ClimateSeed makes it easy to meet your environmental goals with integrity and transparency.

Every project ClimateSeed works with undergoes a **strict selection process,** onboarding and evaluation assessment. Our acceptance standards are grounded in the most current scientific insights and reflect the best practices shared by respected global organizations and experts, including ICVCM and SBTi. This alignment ensures that each project meets the highest standards of environmental integrity and impact.

1. **Initial quality screening:** Ensuring every project is certified by an international standard and independently verified.
2. **Banking due diligence:** All project carriers undergo strict KYC and AML for a full legal standing and reputational analysis.
3. **Project evaluation:** Every project is rigorously assessed to maximize environmental integrity, social safeguards, and alignment with global standards.



BEYOND YOUR VALUE CHAIN

Support carbon removal and avoidance projects

Contribute to carbon removal and avoidance projects **carefully selected by our experts,** offering significant socio-economic and environmental co-benefits.

VCM strategy | Carbon credits sourcing | Project financing

Carbon standards

Discover our selection process ↗

References

[1] ClimateSeed. (2024, November 8). What is the difference between carbon removal and avoidance projects? https://climateseed.com/blog/what-is-the-difference-between-carbon-removal-and-carbon-avoidance-projects

[2] Science Based Targets. (2024, March). Corporate net-zero standard criteria v1.2. https://sciencebasedtargets.org/resources/files/Net-Zero-Standard-Criteria.pdf

[3] Parry, E., Mannion, P., Siccardo, G., & Patel, M. (2022, June 10). Now the IPCC has recognized that carbon removals are critical to addressing climate change, it’s time to act. McKinsey & Company. https://www.mckinsey.com/capabilities/sustainability/our-insights/sustainability-blog/now-the-ipcc-has-recognized-that-carbon-removals-are-critical-to-addressing-climate-change-its-time-to-act

[4] IPCC Sixth Assessment Report. (n.d.). WGIII summary for policymakers headline statements. WGIII. https://www.ipcc.ch/report/ar6/wg3/resources/spm-headline-statements/

[5] Biochar production technologies. International Biochar Initiative. (2023, January 18). https://biochar-international.org/about-biochar/how-to-make-biochar/biochar-production-technologies/

[6] Verra. (2024b, September 25). VM0044 methodology for biochar utilization in soil and non-soil applications, v1.1. https://verra.org/methodologies/vm0044-methodology-for-biochar-utilization-in-soil-and-non-soil-applications/

[7] Zhu, X., Labianca, C., He, M., Luo, Z., Wu, C., You, S., & Tsang, D. C. W. (2022). Life-cycle assessment of pyrolysis processes for sustainable production of biochar from agro-residues. Bioresource Technology, 360, 127601. https://www.sciencedirect.com/science/article/abs/pii/S0960852422009300

[8] Metz, B., Davidson, O., de Coninck, H., Loos, M., & Meyer, L. (2005). Carbon dioxide capture and storage. IPCC. https://www.ipcc.ch/report/carbon-dioxide-capture-and-storage/

[9] Iea. (2024, April 25). Bioenergy with carbon capture and storage - energy system. IEA. https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/bioenergy-with-carbon-capture-and-storage

[10] Vandermel, J. (2020, November 15). Preventing climate change with BECCS: Bioenergy with carbon capture and storage. Princeton University. https://psci.princeton.edu/tips/2020/11/15/preventing-climate-change-with-beccs-bioenergy-with-carbon-capture-and-storage

For more information, get in touch with our team of experts.

Contact us

climateseed.com

ClimateSeed